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Anatomy of lumbar facet joint: a comprehensive review

Running head: Anatomy of lumbar facet joint

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Abstract

Lumbar Facet Joints (LFJs) are diarthrodial joints which provide articulation between two adjacent lumbar vertebrae. LFJs represent complex anatomic structures with multifaceted biomechanic and functional characteristics. They are theorized as structures of crucial clinical significance since their degenerative morphologic alterations are frequently related to emergence of low back pain. Despite the emerging interest in describing LFJs anatomy in recent years, precise description of LFJs innervation remains controversial. In this comprehensive review, anatomy and biomechanical importance of LFJs and associated adjacent extra-articular structures are thoroughly presented. Furthermore, LFJs innervation in respect to current literature data is punctually analyzed. Knowledge of anatomy and innervation LFJs of critical importance for clinicians and spine surgeons, so that patients are properly evaluated and related therapeutic procedures are rationally performed.

Key-words: lumbar vertebrae, zygapophyseal joints, mammilloaccessory ligament, biomechanics, facet joint tropism, dorsal ramus, medial branch

Introduction

Facet joints, which are also classically described as apophyseal or zygapophyseal joints, represent the only synovial joints of spine [16,26]. They are paired diarthrodial joints, posterolaterally articulating the posterior arch between adjacent vertebral levels [26]. Lumbar Facet Joints (LFJs) constitute primary stabilizers of vertebral column, enabling alongside movements as extension, flexion and rotation [4,31].

Aim of this review article is to describe the precise anatomy of LFJs according to contemporary literature data. Particular emphasis in innervation of LFJs is given.

Anatomy of Articular and Extra-articular Elements

Articular Processes and Cartilage

LFJs are comprised by the articulation of superior and underlying adjacent vertebra via the paired inferior and superior articular processes, respectively [10,16]. The major superior and the minor inferior articular processes (SAP and IAP) represent bony protuberances, emerging vertically from the coalescence of pedicles and laminae of respective vertebral arch, posteriorly to the ipsilateral transverse process [16,26]. SAP and IAP are lined with articular hyaline cartilage over the subchondral bone [26]. Hyaline cartilage of LFJs is characterized by poor vascularization and cellular infiltration, featuring a considerable healing inability after traumatization [24]. Articular surfaces of SAP and IAP feature a consistently different morphological pattern. Hence, SAP are characterized by a more concave articular surface, whereas IAP by a more convex one [16,24]. In addition, orientation of SAP and IAP in sagittal and coronal planes features a noteworthy differentiation. IAP of superior vertebral level faces an anterior and lateral direction, whereas SAP lies posteriorly, facing medially [26].

LFJs Articular Cavity

LFJs cavity may be anatomically divided in the FJ articular space and the FJ recesses, featuring a capacity of 1-2 ml [26,36]. FJ space represents the anatomic space between the articular cartilage of articulating facets [36]. In contrast, FJ recesses are formed by the redundant encapsulation of LFJ by Capsular Ligament at the superior and inferior parts of the joint, containing adipose tissue or minor synovial villi [10]. Thorpe Lewis et al. studied 19 cadaveric specimens in order to determine the precise anatomic characteristics of FJ recesses in various spinal regions. It was concluded that FJ recesses presented specific characteristics in respect to particular intervertebral levels. LFJs recesses were equally large and anteromedially and posteromedially located. The anteromedial recess was encountered superiorly, emerging over the upper end of SAP of underlying vertebra. In contrast, posteromedial recess surrounded the lower edge of IAP of supernatant vertebra. LFJs cavity featured no direct communication with the retrodural space, demonstrating an anatomically clear delimitation [36]. LFJ cavity and recesses are detectable in radiologic evaluation with MRI (Figure 1).

LFJs Capsular Ligament

LFJs are, similarly to other synovial diarthrodial joints, completely encapsulated by a Capsular Ligament (LFCL). LFCL is histologically composed by two distinct layers; an outer layer of parallel with lateral-medial direction and densely organized collagen bundles, and an inner layer of elastic fibers with inconsistent orientation [5,16]. Furthermore, LFCL features rich innervation with autonomic and nociceptive nerve fibers, which may reproduce pain in cases of inflammatory or mechanical irritation [26,31].

LFCL has an important role in maintaining the stability of LFJs. The presence of collagen and elastin administrates substantial mechanical support against shear and tensile forces developed during motion and vertebral loading. LFCL bears a remarkable biomechanical role during various movements of LFJs. It is extended during LFJs lateral bending or rotation. Hence, lateral-medial orientated capsular fibers feature extension along LFJs direction, providing functional resistance and stability. On the other hand, flexion or extension of LFJs is associated with emergence of crucial shear stress, transverse to LFJs direction. In this dynamic condition, LFCL fibers feature also a shear stress transverse to their alignment, providing great resistance [5].

Mammilo-accessory Ligament (MAL)

Mammilo-accessory ligament (MAL) represents a ligamentous structure bridging the bony mammillary (MP) and accessory processes (AP) of the lumbar vertebra bilaterally. MP constitutes a circular bony protuberance located at the posterior border of SAP. AP is, on the other side, a relatively lesser and sharpening bony structure encountered at the postero-inferior portion of each transverse process root. Ipsilateral MP and AP are connected by the ligamentous MAL (Figure 2) [12]. MAL constitutes a portion of the medial aspect of intertransverse ligament, featuring a noteworthy tendency to ossification [31].

Shuang et al. dissected 12 cadaveric specimens, in order to determine the precise anatomy of medial branch of spinal dorsal ramus. It was inter alia concluded that the abovementioned anatomic structures form a true fibro-osseous canal, which is anatomically characterized by 4 distinct walls; a superior (MP), an inferior (AP), an anterior (the bony groove between MP and AP) and a posterior (MAL). The fibro-osseous canal displays an oblique direction, encountered at the dorsal portion of SAP and origin of transverse process [31]. In the case of MAL ossification, this canal becomes completely osseous [12,31].

Biomechanical Data

The three-dimensional LFJs and the anteriorly located intervertebral disc at each lumbar spine level compose an anatomic entity described as spinal segment, “three-joint complex” or articular triad [15,16,21,23,26,32,38]. These articular structures are theorized to constitute a single unit since the emergence of degenerative alterations in one joint has a subsequent influence on the biomechanic behavior of the whole unit [26]. Furthermore, the harmonized function of these structures prevents potentially injurious dynamic states, warranting alongside physiological motional activity.

Functionally, the intervertebral disc is majorly responsible for the transmission of axial-compressive forces [16]. In contrast, osseous LFJs are primarily charged with the stabilization of spinal motion segment [2,3,16]. However, many biomechanical studies have demonstrated that LFJs also contribute to transfer of implemented axial compressive load on

the spine [1,24,26,28,32] LFJs may bear up to 25% of this load, depending on the motion status at each case [24,41]. However, the underlying mechanisms of this transmission remain unclear. The nearly vertical inclination of LFJs articular surfaces in conjunction with the existent low friction considerably complicates this description. Inoue et al. reviewed existing literature data on the biomechanical behavior of LFJs in various dynamic conditions. It was concluded that LFJs may contribute to axial compressive load transfer by three potential mechanisms; by articular surfaces, by LFCL and by the direct connection between the vertebral arch or the pars interarticularis and the tips of articular processes [16].

As stated above, LFJs have been delineated as the primordial lumbar spine stabilizers [22,32]. LFJs stabilize the respective motion segment in extension and flexion, restricting also axial rotation [26,39]. More specifically, medial and posterior portion of LFJs instates the major resistance to antero-olisthesis [3]. Comparatively, anatomic construction of LFJs relatively allows flexion-extension motions in sagittal planes, but noteworthy limits axial rotation, so that rotatory instability is prevented [32,39].

Nevertheless, this motion-restrictive pattern may vary according to each lumbar level. This variation is majorly attributed to the differentiated LFJs orientation. LFJs are oriented 82-86 degrees in regards to the axial plane and 15-70 degrees in regards to the sagittal [5]. Nonetheless, LFJs orientation features a gradual coronal to sagittal conversion from proximal to distal levels [3]. At L1-L2 spinal motion segment, the angle between articular surfaces of SAPs is 30 degrees. However, this angle features a considerable distribution from 30 to 90 degrees in distal (L4-S1) segments. This peculiarity of LFJs orientation in distal segments is profoundly responsible for the emergence of lower resistance to rotational motion [3,22]. Particular anatomic studies have depicted that the orientation of LFJs gradually approaches the sagittal plane with age [19]. However, the precise contribution of this alteration to further degenerative damage of spinal segment is not adequately understood [18].

LFJs Tropism (LFJT)

LFJT is defined as the existing asymmetry between right and left LFJs angle [8,13,17,37,40]. Bogduk et al. initially described LFJT as the status where LFJs feature a rotational incongruity in respect to axial plane, resulting in subsequent asymmetry [6]. More

recent studies identified that LFJT may be present in all planes. Therefore, LFJT may also be theorized as the subsistence of asymmetry between left and right LFJs angles in sagittal or coronal planes as well [3,26]. This asymmetry is in the majority of cases relatively negligible, under 5 degrees in range. There is currently no universal consensus about the consideration of clinically significant LFJT. Hence, LFJs angulation may normally vary from 5 to 10 degrees [3].

Mohanty et al. performed a retrospective cross-sectional study, in order to elucidate the prevalence of LFJT. For this purpose, 566 intact spinal motion segments from 124 CT scans of spinal trauma patients were analyzed. Results shown that LFJT featured greater prevalence in L4-L5 and L5-S1 levels, with the percentages 47.82% and 38.5%, respectively. Authors concluded that these results may offer an explanation for the more frequent occurrence of lumbar disc herniation and related degenerative disorders as lumbar arthrosis and degenerative spondylolisthesis encountered at these levels [23]. This thesis has been also adopted from other studies in recent literature [3,14,26].

LFJs Innervation

LFJs innervation is derived by the medial branch of the lumbar dorsal rami, or, as also known, posterior branches of the lumbar spinal nerves [31]. For many years, clinical importance of these structures was not adequately recognized. Hence, precise description of their anatomy was not even in well-established anatomy atlases present [19]. Bogduk et al. were the first to provide a thorough analysis of posterior branches of lumbar spinal nerves anatomy in 1982 [7].

The spinal nerve is divided into four distinct branches, after its exit from the respective intervertebral foramen; the communicating branch, the meningeal branch, the ventral ramus (VR) and the smaller dorsal ramus (DR) [31]. At levels L1-L4, DR is separated from the spinal nerve at an approximately right angle [19,29]. They subsequently traverse the vertebral foramen, featuring then a dorsal and caudal course [7,9,30]. DR is from that point encountered at the orifice formed by the superior border of the adjacent transverse processes and the inferior border of the respective LFJ [19,20]. This final aspect of DR is located at the medial portion of intertransverse musculature (Figure 3) [31].

DR bifurcates, circa 5-10mm distal to the abovementioned orifice, into a medial and a lateral branch, forming a 30-degree angle [19,20]. This division is encountered at the superior edge of the underlying transverse process. There are multiple communicating branches between the adjacent lateral branches, medial branches and dorsal rami [31]. Nerve fibers composition for both branches is duplex, containing sensory as well as motor fibers. Ramification of DR presents also a regional significance; lateral branch innervates tissues lateral to LFJs whereas medial provides innervations to the structures located medially to LFJs line [33] (Figure 3).

Bogduk et al. proposed that ramification of DR is triple, describing also a distinct intermediate branch in addition to medial and lateral [7]. This thesis was later adopted from other authors as well. Middle or intermediate branch may co-exist with lateral branch in a short common trunk or separate directly from the DR. It is theorized that middle branch provides innervation to the longissimus lumbar muscle [19]. Furthermore, middle branch may also feature rich anastomoses with the other branches, thereby composing complex neural plexuses. Despite the published data about the anatomy of intermediate branch, dichotomy of DR into medial and lateral branches represents the majorly acceptable standard in the literature [31].

After its emergence, medial branch traverses the superior border of the underlying transverse process, proximal to its origin [27]. It then passes between the bases of SAP and adjacent transverse process, traversing the dorsal portion of intertransverse ligament. Medial branch is at this locus accompanied by the posterior branch of the lumbar artery, adhering to the adjacent periosteum via connective tissue [19]. Farther on, it features a medial course passing under the MAL into the fibro-osseous canal. Medial branches of L1-L4 dorsal rami are encountered at the posterolateral portion of this canal, featuring greater proximity to AP than the MP [11]. They subsequently follow a medial and caudal route towards the vertebral lamina, demonstrating thereafter a deep course into the adipose tissue of multifidus muscle [19]. Medial branch is there ramified into three distinct branches; muscular, articular and cutaneous branch, supplying LFJs, multifidus muscles and supra- and inter-spinous ligaments (Figure 3) [7,19,31].

The anatomic course and distribution of medial branch may feature considerable variability, complicating thus the punctual description of LFJs innervation [19]. Bogduk et al. stated in their paper that medial branch provides innervation to LFJs of respective level and

one level caudally with descending branches [7]. This statement was in general validated from the vast majority of subsequently published papers [11,19,29,31] (Figure 3). There is, however, existing literature data supporting that LFJs innervation may be more complex, with emerging branches of sympathetic trunk and adjacent spinal ganglion participating as well [19,25,34,35].

In their cadaveric study, Shuang et al. concluded that innervation of a particular LFJs is provided by medial branches of the 2 adjacent DR. Medial branches of lumbar DR demonstrate a terminal descending portion, which may extend to 1-3 intervertebral levels. Medial branches of cranial DR tend to finally exhibit a shorter descending course in contrast to caudal. Furthermore, it was elucidated that articular branches from medial branch are also derived prior to entrance in fibro-osseous canal. These branches provide regional innervation to lateral and inferior portion of LFJs, whereas the terminally separated articular branches supply superior and medial aspects of LFJs [31].

L5 spinal segment features special anatomic characteristics in terms of neural distribution. First, DR presents a longer course than VR, rising at the excavation between the superior surface of sacral ala and the base of S1 SAP [19, 26]. Perolat et al. reviewed existing literature on facet joint syndrome, quoting alongside data about LFJs anatomy. It was stated that L5 DR is bifurcated into a medial and an intermediate branch, with no presence of lateral branch [26]. However, this thesis is not universally accepted [31]. Medial branch of L5 DR subsequently runs caudally, giving rise to communicating branches to S1 DR [26].

Conclusions

Existing literature evidence indicates that LFJs represent complex structures in terms of anatomy, biomechanical sententiousness and functional importance. Despite the emerging interest on describing LFJs anatomy, a precise and universally accepted description of LFJs innervation remains absent. Future anatomic and radiologic studies with greater size of specimens may clarify this issue, contributing thus to better comprehension and optimization of particular interventional procedures as LFJs denervation.

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References

1. Adams MA, Hutton WC. The mechanical function of the lumbar apophyseal joints. *Spine* 1983;8:327–330.
2. Ahmed AM, Duncan NA, Burke DL. The effect of facet geometry on the axial torque-rotation response of lumbar motion segments. *Spine (Phila Pa 1976)*. 1990;15:391-401.
3. Alonso F, Kirkpatrick CM, Jeong W, et al. Lumbar Facet Tropism: A Comprehensive Review. *World Neurosurg*. 2017;102:91- 96, doi:10.1016/j.wneu.2017.02.114.
4. An SJ, Seo MS, Choi SI, et al. Facet joint hypertrophy is a misnomer: A retrospective study. *Medicine (Baltimore)*. 2018;97(24):e11090, doi:10.1097/MD.00000000000011090
5. Ban E, Zhang S, Zarei V, Barocas VH, Winkelstein BA, Picu CR. Collagen Organization in Facet Capsular Ligaments Varies With Spinal Region and With Ligament Deformation. *J Biomech Eng*. 2017;139(7):0710091-0710099, doi:10.1115/1.4036019
6. Bogduk N. *Clinical Anatomy of the Lumbar Spine and Sacrum*. 3rd ed. Churchill Livingstone, Edinburgh, 1997.
7. Bogduk N, Wilson AS, Tynan W. The human lumbar dorsal rami. *Journal of Anatomy* 1982; 134(Pt2):383-397.
8. Chadha M, Sharma G, Arora SS, et al. Association of facet tropism with lumbar disc herniation. *Eur Spine J*. 2013;22:1045-1052.
9. Cohen SP, Raja SN. Pathogenesis, Diagnosis, and Treatment of Lumbar Zygapophysial (Facet) Joint Pain. *Anesthesiology* 2007; 106:591-614.
10. Demir-Deviren S, Singh S, Hanelin J. Superior Recess Access of the Lumbar Facet Joint. *Clin Spine Surg*. 2017;30(3):E169- E172, doi:10.1097/BSD.0000000000000271.
11. Demondion X, Vidal C, Glaude E, et al. The posterior lumbar ramus: CT-anatomic correlation and propositions of new sites of infiltration. *AJNR Am J Neuroradiol*. 2005;26(4):706- 710.
12. Dupont G, Yilmaz E, Iwanaga J, et al. Ossification of the mamillo-accessory ligament: a review of the literature and clinical considerations. *Anat Cell Biol*. 2019;52(2):115- 119, doi:10.5115/acb.2019.52.2.115
13. Farfan HF, Sullivan JD. The relation of facet orientation to intervertebral disc failure. *Can J Surg*. 1967;10:179-185.
14. Gao T, Lai Q, Zhou S, et al. Correlation between facet tropism and lumbar degenerative disease: a retrospective analysis. *BMC Musculoskelet Disord*. 2017;18(1):483, doi:10.1186/s12891-017-1849-x.
15. Gellhorn AC, Katz JN, Suri P. Osteoarthritis of the spine: the facet joints. *Nat Rev Rheumatol*. 2013;9:216-224.

16. Inoue N, Orias AAE, Segami K. Biomechanics of the Lumbar Facet Joint. *Spine Surg Relat Res*. 2019;4(1):1- 7, doi:10.22603/ssrr.2019-0017.
17. Ishihara H, Matsui H, Osada R, et al. Facet joint asymmetry as a radiologic feature of lumbar intervertebral disc herniation in children and adolescents. *Spine (Phila Pa 1976)*. 1997;22:2001-2004.
18. Jiang X, Chen D, Li Z, et al. Correlation between Lumbar Spine Facet Joint Orientation and Intervertebral Disk Degeneration: A Positional MRI Analysis. *J Neurol Surg A Cent Eur Neurosurg*. 2019;80(4):255- 261, doi:10.1055/s-0039-1683450.
19. Kozera K, Ciszek B. Posterior Branches of Lumbar Spinal Nerves - Part I: Anatomy and Functional Importance. *Ortop Traumatol Rehabil*. 2016;18(1):1- 10, doi:10.5604/15093492.1198827.
20. Kozera K, Ciszek B, Szaro P. Posterior Branches of Lumbar Spinal Nerves - part II: Lumbar Facet Syndrome - Pathomechanism, Symptomatology and Diagnostic Work-up. *Ortop Traumatol Rehabil*. 2017;19(2):101- 109, doi:10.5604/15093492.1237716
21. Louis R. Spinal stability as defined by the three-column spine concept. *Anat Clin*. 1985;7:33-42.
22. Mahato NK. Facet dimensions, orientation, and symmetry at L5-S1 junction in lumbosacral transitional States. *Spine (Phila Pa 1976)*. 2011;36(9):E569- E573, doi:10.1097/BRS.0b013e3181f6ecb2.
23. Mohanty SP, Pai Kanhangad M, Kamath S, et al. Morphometric study of the orientation of lumbar zygapophyseal joints in a South Indian population. *J Orthop Surg (Hong Kong)*. 2017;25(3):2309499017739483, doi:10.1177/2309499017739483.
24. O'Leary SA, Link JM, Klineberg EO, et al. Characterization of facet joint cartilage properties in the human and interspecies comparisons. *Acta Biomater*. 2017;54:367- 376, doi:10.1016/j.actbio.2017.03.017.
25. Pedersen HE, Blunck CF, Gardner E. The anatomy of lumbosacral posterior rami and meningeal branches of spinal nerves (sinuvertebral nerves). *Journal of Bone and Joint Surgery* 1956;38:377-391.
26. Perolat R, Kastler A, Nicot B, et al. Facet joint syndrome: from diagnosis to interventional management. *Insights Imaging*. 2018;9(5):773- 789, doi:10.1007/s13244-018-0638-x.
27. Proietti L, Schirò GR, Sessa S, et al. The impact of sagittal balance on low back pain in patients treated with zygoapophysial facet joint injection. *Eur Spine J*. 2014;23 Suppl 6:628- 633, doi:10.1007/s00586-014-3559-5.
28. Putz R. The functional morphology of the superior articular processes of the lumbar vertebrae. *J Anat*. 1985;143:181-187.
29. Saito T, Steinke H, Miyaki T, et al. Analysis of the posterior ramus of the lumbar spinal nerve: the structure of the posterior ramus of the spinal nerve. *Anesthesiology* 2013;118(1):88-94, doi:10.1097/ALN.0b013e318272f40a.
30. Saito T, Yoshimoto M, Yamamoto Y, et al. The medial branch of the lateral branch of the posterior ramus of the spinal nerve. *Surg Radiol Anat*. 2006;28(3):228-234, doi:10.1007/s00276-006-0090-3.
31. Shuang F, Hou SX, Zhu JL, et al. Clinical Anatomy and Measurement of the Medial Branch of the Spinal Dorsal Ramus. *Medicine (Baltimore)*. 2015;94(52):e2367, doi:10.1097/MD.0000000000002367.
32. Song Q, Liu X, Chen DJ, et al. Evaluation of MRI and CT parameters to analyze the correlation between disc and facet joint degeneration in the lumbar three-joint complex. *Medicine (Baltimore)*. 2019;98(40):e17336, doi:10.1097/MD.00000000000017336.
33. Steinke H, Saito T, Miyaki T, et al. Anatomy of the human thoracolumbar Rami dorsales nervi spinalis. *Ann Anat*. 2009;191(4):408- 416, doi:10.1016/j.aanat.2009.04.002.

34. Suseki K, Takahashi Y, Takahashi K, et al. Innervation of the lumbar facet joints. Origins and functions. *Spine (Phila Pa 1976)*. 1997;22(5):477- 485, doi:10.1097/00007632-199703010-00003.
35. Tessitore E, Molliqaj G, Schatlo B, et al. Clinical evaluation and surgical decision making for patients with lumbar discogenic pain and facet syndrome. *Eur J Radiol*. 2015;84(5):765- 770, doi:10.1016/j.ejrad.2014.03.016.
36. Thorpe Lowis CG, Xu Z, Zhang M. Visualisation of facet joint recesses of the cadaveric spine: a micro-CT and sheet plastination study. *BMJ Open Sport Exerc Med*. 2018;4(1):e000338, doi:10.1136/bmjsem-2017-000338.
37. Tulsi RS, Hermanis GM. A study of the angle of inclination and facet curvature of superior lumbar zygapophyseal facets. *Spine (Phila Pa 1976)*. 1993;18:1311-1317.
38. Twomey L, Taylor J. Age changes in lumbar intervertebral discs. *Acta Orthop Scand*. 1985;56:496-499.
39. Varlotta GP, Lefkowitz TR, Schweitzer M, et al. The lumbar facet joint: a review of current knowledge: part 1: anatomy, biomechanics, and grading. *Skeletal Radiol*. 2011;40:13–23.
40. Wang H, Zhang Z, Zhou Y. Irregular Alteration of Facet Orientation in Lumbar Segments: Possible Role in Pathology of Lumbar Disc Herniation in Adolescents. *World Neurosurg*. 2016;86:321- 327, doi:10.1016/j.wneu.2015.09.029.
41. Yang KH, King AI. Mechanism of facet load transmission as a hypothesis for low-back pain. *Spine (Phila Pa 1976)*. 1984;9:557–565.

Figure 1. Representation of FJ cavity (red arrow) and the anteriomedially located superior recess (white arrow) of L3-L4 FJ in a normal lumbar MRI.

Figure 2. Conceivable representation of MAL in an anteroposterior lumbar spine radiograph.

Figure 3. Schematic representation of lumbar DR and its branches (1: Lumbar spinal nerve, 2: Ventral Ramus, 3: Dorsal Ramus, 4: Medial Branch of Dorsal Ramus, 5: Lateral Branch of Dorsal Ramus, 6: Muscular Branch of Medial Branch of Dorsal Ramus, 7: Articular Branches of Medial Branch of Dorsal Ramus, 8: Cutaneous Branches of Medial Branch of Dorsal Ramus).





